TABLE 1.—*Solar radiation intensities during November, 1917*—Contd.

Santa Fe, N. Mex.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	65.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Nov. 1		1.50	1.36							
3		1.58				1.24	1.19		1.15	
5		1.50	1.38							
6		1.45	1.39			1.29	1.22	1.14		
8		1.52	1.39			1.20	1.13	1.07	1.01	
16			1.24				1.11			
19									1.13	1.01
21						1.31	1.22	1.15		
Monthly means		1.51	1.35			1.26	1.17	1.12	1.10	(1.01)
Departure from 6-year normal		−0.05	−0.12			−0.01	−0.03	−0.02	−0.06	
P. M.										
Nov. 1			1.43	1.34	1.27	1.21	1.14	1.09		
3			1.38	1.35	1.26	1.16	1.13			
5			1.44	1.34	1.23	1.13				
8					1.25					
12					1.17	1.12	1.04	0.97		
16						1.17	1.13			
20				1.39	1.30	1.21				
22					1.27	1.23	1.17			
23			1.44	1.38	1.32	1.27				
Monthly means			1.42	1.36	1.26	1.19	1.12	(1.03)		
Departure from 2-year normal			−0.03	−0.04	−0.04	−0.04	−0.04	−0.08		

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C. Dates.	8 a. m.	8 p. m.	Madison, Wis. Dates.	8 a. m.	8 p. m.	Lincoln, Nebr. Dates.	8 a. m.	8 p. m.	Santa Fe, N. Mex. Dates.	8 a. m.	8 p. m.
1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*
Nov. 1	4.37	3.15	Nov. 3	3.81	5.36	Nov. 2	3.15	4.57	Nov. 1	2.49	3.15
2	3.15	3.00	5	4.75	6.50	3	3.99	4.57	3	3.45	2.62
3	3.99	4.37	16	4.95	6.76	5	4.57	2.74	5	2.49	2.26
4	3.63	4.37	20	4.37	6.76	6	4.17	5.56	6	1.88	2.36
5	3.30	4.57				7	2.36	7.57	8	1.96	3.45
6	3.99	4.95				14	4.57	5.79	12	3.81	3.63
7	4.37	3.15				16	5.16	12.68	16	3.63	2.36
8	2.74	3.45				18	3.99	2.87	19	2.74	2.87
10	3.99	5.79							20	2.87	3.00
12	5.56	7.04							21	2.06	2.74
17	4.37	5.56							22	2.49	3.45
26	3.45	2.36							23	2.87	3.00

TABLE 3.—*Daily totals and departures of solar and sky radiation during November, 1917.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals. Washington.	Daily totals. Madison.	Departures from normal. Washington.	Departures from normal. Madison.	Excess or deficiency since first of month. Washington.	Excess or deficiency since first of month. Madison.
1917.	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*
Nov. 1	268	151	7	−46	7	−46
2	315	177	58	−18	65	−64
3	315	265	62	73	127	9
4	350	244	101	55	228	64
5	345	261	100	75	328	139
6	259	205	17	21	345	160
7	306	50	67	−131	412	29
8	329	137	92	−41	504	−12
9	246	178	12	2	516	−10
10	268	150	37	−23	553	−33
11	218	205	−11	34	542	1
12	195	38	−31	−130	511	−129
13	56	55	−167	−110	344	−239
14	195	119	−25	−44	319	−285
15	230	222	12	62	331	−221
16	198	222	−17	64	314	−157
17	231	195	19	39	333	−118
18	254	203	44	49	377	−69
19	246	112	39	−40	416	−109
20	237	204	32	54	448	−55
Decade departures					−105	−22
21	104	154	−98	6	350	−49
22	154	63	−46	−83	304	−132
23	206	131	9	−13	313	−145
24	104	99	−91	−43	222	−188
25	260	88	68	−52	290	−240
26	225	112	35	−27	325	−267
27	159	43	−29	−94	296	−361
28	52	115	−134	−21	162	−382
29	31	56	−153	−80	9	−462
30	13	66	−169	−68	−160	−530
Decade departures					−608	−475
Excess or deficiency since first of year. gr.-cal.					−6,768	+147
Excess or deficiency since first of year. per cent					−5.5	+0.1

OBSERVATIONS OF THE NEUTRAL POINTS OF ATMOSPHERIC POLARIZATION FROM GREAT HEIGHTS.[1]

By A. WIGAND.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §866.]

Observations of the positions of the neutral points of Arago and Babinet were made in the early morning of May 3, 1914, from a free balloon. The balloon started from Bitterfeld at 3:14 a. m., Middle European Time, and observations of polarization were obtained from 3:59 to 5:35 a. m., during which time the balloon rose from 3,100 to 5,850 meters. The angular distances of Arago's Point are plotted against the elevation of the sun and compared with corresponding observations made on the earth's surface, showing that the elevation from which the observations were made did not affect the position of the neutral point. Similarly the distances of Babinet's Point from the sun are shown to be unaffected by variation in height of the point of observation, within the limits of accuracy of observation.

The conclusion provisionally drawn from the few observations available is that the phenomena of polarization do not belong exclusively to the lower layers. As they show no appreciable change in the first 6,000 meters they are possibly to be considered as a property of the stratosphere.—*R. C*[*orless*].

SOME NUCLEI OF CLOUDY CONDENSATION—III.[2]

551.510.4(048)

By J. AITKEN.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §864.]

The nuclei of the atmosphere, formerly termed by the author dust particles, but now recognized to be very much smaller than the ordinary particles of dust raised in a wind, have been the subject of a good deal of investigation. Of late it has been definitely stated by some workers that these nuclei are mere aggregations of ions and not of the nature of dust particles. The present investigation was carried out to test this theory, and incidentally many subsidiary experiments were made. A new piece of apparatus was devised in which the saturated sample of air in a test flask could readily and almost instantaneously be expanded, and thus given any degree of supersaturation within reasonable limits. The "size" of the nuclei is measured by the degree of supersaturation required to produce condensation upon them, a 2 per cent expansion of the air in the test flask being sufficient to cause condensation upon the larger nuclei, while higher degrees of supersaturation are required for the smaller ones, until a 25 per cent expansion is required to produce condensation on individual ions. The "size" of the nuclei measured in this way does not necessarily mean the relative dimensions, though probably not far from it.

With the aid of the new apparatus tests were made on the effect of heat acting on different materials, as a nucleus producer. It was found that when any material became sufficiently heated to cause an alteration in the flame in contact with it then nuclei were produced. This held in the case of glass, porcelain, alundum, and also with copper and other metals. This production of nuclei from heated surface affords some explanation of the wearing away of bars of grates and linings of furnaces in cases where these are not exposed to friction. Some metals, as magnesium, were found to have the

[1] Physikal. Ztschr., June 1, 1917, 18: 237-240.
[2] Proc., Roy. soc., Edinburgh, 1916-1917, 37: 215-245.

power of producing nuclei when cold, while others, as aluminum, had little effect. Experiments with ordinary air and with the pure air found in the neighborhood of Loch Awe both showed that whereas large nuclei were present, small nuclei requiring more than a 6 per cent expansion to produce condensation were generally absent. This did not support the theory that nuclei are aggregations of ions, since in this case nuclei of all sizes from that of a single ion upward would be expected. Some tests were made with air ionized by means of radium salts, but even after long intervals extending up to a day no tendency was observed for the ions to combine and produce large nuclei. It is therefore considered as proved that the "large ions of the atmosphere" are in reality nuclei to which an ion has become attached and given up its charge. The paper contains much detail information which can not be summarized in an abstract.—*J. S. Di[nes]*.

RELATION BETWEEN SUNLIGHT AND MOONLIGHT.[1]

By J. S. Dow.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §931.]

Taking sunslight to be equivalent to 10,000 candle-feet (for perpendicular incidence from an unclouded sky), the corresponding illumination from the full moon is calculated to be 0.02 candle-foot. The author finds this to be very near the value he obtained by actual measurement. The range of illumination between sunlight and moonlight is thus of the order of 1 to 500,000.—*C. P. B[utler]*.

[See this REVIEW for June, 1914, p. 347 for another estimate of the moon's brightness.]

551.510.5 (048)

MINUTE STRUCTURE OF THE SOLAR ATMOSPHERE.[2]

By G. E. HALE & F. ELLERMAN.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §873.]

A short summary is given of the result of an extensive investigation of spectroheliograms showing the structure of the solar atmosphere at various levels in comparison with that of the low-lying photosphere and sunspots. For the photosphere Langley's "rice grains" and "granules" are still the best standards for denoting the minute structure, the granules being about 0.3 second in diameter (say about 130 miles). Photographs taken with the spectroheliograph in calcium light can be made to show details at different levels according to the slit setting. The smallest calcium flocculi observed are less than 1 second in diameter. In the case of the highest levels shown by the dark hydrogen flocculi in Hα-light, the smallest flocculi are about 2 seconds in diameter. This seems to support the view that the photosphere and gaseous atmosphere above it are formed of columns of hot gases, rising by convection from the interior of the sun. To illustrates these difference of level a stereoscopic picture is given of a dark hydrogen flocculus floating over the region of a large spot group on 1915, August 7, the vortex action of the spots is also well shown by the bending of the hydrogen flocculus near the spot umbræ. It is concluded that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular regions are replaced by slender filaments, lying side by side, resembling the structure of penumbræ of sunspots.—*C. P. B[utler]*.

The present editor reprints below the last paragraph of the original proceedings of the National Academy of Sciences, February, 1916, **2**:108:

> We have shown in this paper that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular elements (minute flocculi) are replaced by numerous slender filaments, lying side by side, and recalling the structure of the penumbra in sun spots. While these results appear to support the hypothesis that the solar atmosphere consists of parallel columns of ascending and expanding gases, which are drawn out horizontally in spot penumbræ and in disturbed regions of the chromosphere, such questions as the dimensions of the columns and the direction of motion and velocity of the vapor in sun spots and in the atmosphere about them are reserved for subsequent discussion.

523.4 (048)

WHY THE AXES OF THE PLANETS ARE INCLINED.

By Prof. WILLIAM H. PICKERING

(Harvard College Observatory, Mandeville, Jamaica, B. W. I.).

[*Reprinted from* Popular Astronomy, October, 1917, 25.]

[The intimate relation existing between the climates and meteorology of a planet and the inclination of its axis to the plane of the ecliptic, seems sufficient justification for introducing this astronomical discussion here—C. A., jr.]

This question is constantly asked by students of astronomy, and the answer generally given is either that it "just happened so," or else that "nobody knows." In point of fact the answer is not very far to seek. Imagine a large revolving gaseous mass condensed toward the center. Recent observations seem to show that at least one of the nebulæ revolves as one piece, as if it were a solid body, but in general there is no question but that in a loosely formed gaseous mass the outer portions will travel at a lower linear rate than the inner ones. Let figure 1 represent such a condensing gaseous mass, with a huge condensation at *a* and a relatively small one beginning to form at *b*. The shape of the latter is of no consequence, whether it is spherical from the beginning, or merely the portion of an arm of a spiral. In either case its outer portion revolves about *a* more slowly than its inner, as is indicated by the arrows, and if it finally condenses sufficiently to form an independent body, revolving about *a* in a positive direction, its rotation on its own axis will be *negative*, or as we usually describe it *retrograde*.

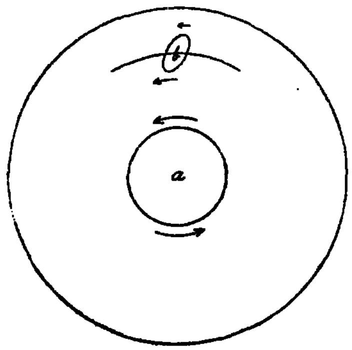

FIG. 1.—Illustrating the origin of the initially retrograde rotation of a satellite or a planet, *b*.

If this is the method by which the planets were formed, which seems not unlikely, why is it then that their rotation is found to be direct instead of retrograde? In point of fact the rotation of the two outermost *is* retrograde as has been known theoretically, from the direction of revolution of their satellites, for many years. Only recently this direction has been confirmed spectroscopically for Uranus at the Lowell Observatory (Lowell Observatory Bulletin No. 53) and the period of rotation found, $10^h\ 50^m$. This period has been confirmed,

[1] Illum. engr., London, April, 1917, 10: 113-114.
[2] Proc., Nat. acad. sci., February, 1916, 2: 102-108.